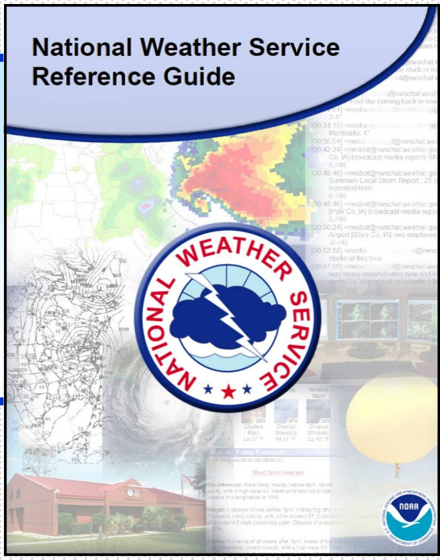

8. Equipment

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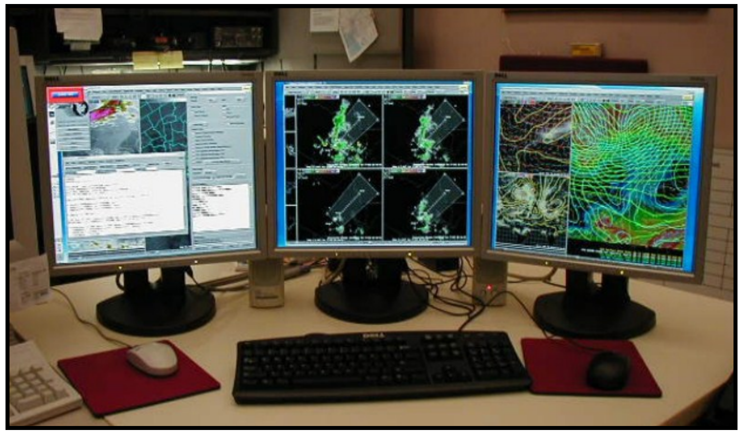
8. Equipment

In order to provide the wide variety of services that the NWS provides, a number of important pieces of equipment are utilized. Some of the basic equipment can be found in any business office in the country. Other instruments are very specific to the NWS or other weather agencies. These instruments will be described here.

The table below is a list of equipment used within NWS offices to aide in daily activities. The list encompasses the major programs used in most or all offices. Local offices may have additional equipment not listed here. Additional equipment and observations from outside of NOAA are utilized, including ship observations and mesonet systems, but will not be discussed here.

EQUIPMENT	USES
Advanced Weather Interactive Processing System (AWIPS)	Display system for hydro-meteorological operations.
Automated Surface Observation System (ASOS)	Sensors measure wind, temperature, moisture, cloud bases, pressure, weather and obscurations.
Cooperative Observation Equipment	Measure temperature, precipitation.
Doppler Weather Radar	Detects precipitation allowing for the display of precipitation.
Hydrologic Observing Systems	Gauges measure river stage/flow.
Marine and Tsunami Buoys	Measure wave heights, wind and pressure or water depth.
NOAA Weather Radio	Official warning and forecast voice of the NWS.
Satellite	Detect cloud tops, temperatures, moisture content, large scale winds, sea surface temperatures.
Radiosonde and tracking system	Measure wind, temperature and moisture of the upper atmosphere.
Wind Profilers	Samples wind speed and direction vertically from one location.

AWIPS

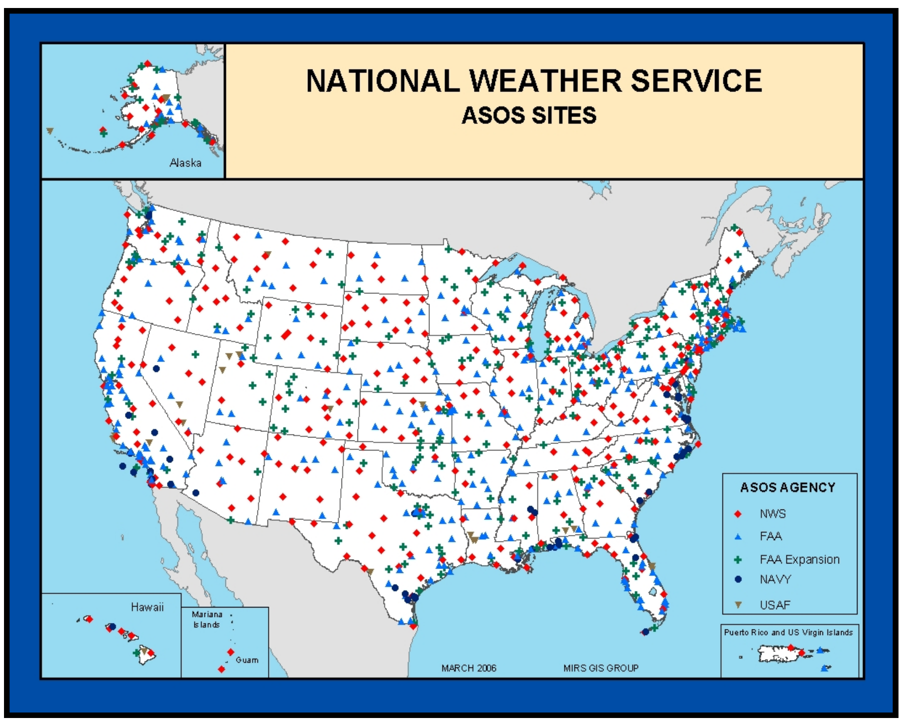


The Advanced Weather Interactive Processing System (AWIPS) is a technologically advanced information processing, display and telecommunications system that is the cornerstone to the forecast process in an NWS office. AWIPS workstations typically have a tri-monitor setup for displaying data and preparing the forecast. Additionally, an AWIPS text workstation is located at each workstation for producing and displaying text products and observations. Data dissemination and acquisition through AWIPS is handled through satellite systems. This allows the network to be independent of land based communication that may be affected by weather or other events.

ASOS

The Automated Surface Observing Systems (ASOS) program is a joint effort of the NWS, the Federal Aviation Administration (FAA), and the Department of Defense (DOD). The ASOS serves as the nation's primary surface weather observing network. ASOS is designed to support weather forecast activities and aviation operations, and at the same time, support the needs of the meteorological, hydrological and climatological research communities.

With the largest and most modern compilation of weather sensors, ASOS has significantly expanded the information available to weather forecasters and the aviation community. The ASOS network has more than doubled the number of full-time surface weather observing locations. ASOS works non-stop, updating observations every minute, 24 hours a day, every day of the year.



Getting more information on the atmosphere more frequently and from more locations is the key to improving forecasts and warnings. Thus, ASOS information helps the NWS to increase the accuracy and timeliness of its forecasts and warnings.

The primary concern of the aviation community is safety, and weather conditions often threaten that safety. A basic strength of ASOS is that critical aviation weather parameters are measured where they are needed most: airport runway touchdown zone(s). ASOS detects significant changes, disseminating hourly and special observations via the networks. Additionally, ASOS routinely and automatically provides computer-generated voice observations directly to aircraft in the vicinity of airports, using FAA ground-to-air radio. These messages are also available via a telephone dial-in port. ASOS observes, formats, archives and transmits observations automatically. ASOS transmits a special report when conditions exceed preselected weather element thresholds, e.g., the visibility decreases to less than 3 miles.
Additional similar observing stations known as Automated Weather Observing Systems (AWOS) are owned by the state or a private company and maintained by private vendors.

Basic weather elements from ASOS:

- Sky condition: cloud height and amount (clear, scattered, broken, overcast) up to 12,000 feet
- Visibility (to at least 10 statute miles)
- Basic present weather information: type and intensity for rain, snow, and freezing rain
- Obstruction to vision: fog, haze
- Pressure: sea-level pressure, altimeter setting
- Ambient temperature, dewpoint temperature
- Wind: direction, speed and character (gusts, squalls)
- Precipitation accumulation
- Selected significant remarks including - variable cloud height, variable visibility, precipitation beginning/end times, rapid pressure change, pressure change tendency, wind shift, peak wind

Sensor Description

SKY CONDITION: ASOS sky condition is determined by a laser ceilometer referred to as the Cloud Height Indicator (CHI). The CHI is used to detect the presence of clouds directly overhead up to 12,000 feet above ground level.

VISIBILITY: ASOS visibility is based on light scattering. The visibility sensor projects a beam of light over a very short distance, and the light that is scattered is detected by a receiver. The amount of light scattered and then received by the sensor is converted into a visibility value.

PRESENT WEATHER AND OBSTRUCTIONS TO VISION: There are two ASOS present weather sensors. The Precipitation Identifier (PI) sensor discriminates between rain (RA) and snow (SN). The Freezing Rain (FZRA) sensor detects freezing rain. ASOS evaluates multiple sensor data and infers the presence of obstructions to vision.

The PI sensor has the capability to detect and report -RA, RA, +RA, -SN, SN, +SN. When rain and snow are mixed and the prevailing precipitation type cannot be determined, ASOS will report UP. The Freezing Rain sensor measures accumulation rates as low as 0.01 inches per hour. If freezing rain is detected and the PI sensor indicates no precipitation or rain, then freezing rain is reported. If freezing rain is detected when the PI indicates snow, then snow is reported.
Obstructions to vision are not directly measured by ASOS, but inferred from measurements of visibility, temperature, and dew point. There are only two reported by ASOS: Fog (FG) and Haze (HZ), and only when the visibility is below 7 statute miles.

TEMPERATURE AND DEW POINT: The ASOS temperature and dew-point sensors directly measure the air and dew-point temperatures.

WIND: ASOS senses wind speed and direction with a sonic wind sensor. This sensor uses sound waves to measure the wind characteristics. Wind character and peak wind are obtained by comparing average and maximum wind speeds.

PRESSURE: Because pressure measurement is critical, three separate and independent pressure sensors are used at larger airports. Two pressure sensors are used at other locations.

PRECIPITATION ACCUMULATION: Most ASOS stations use an All Weather Precipitation Accumulation Gauge designed to accurately measure frozen and liquid precipitation.

COOP Observing Equipment

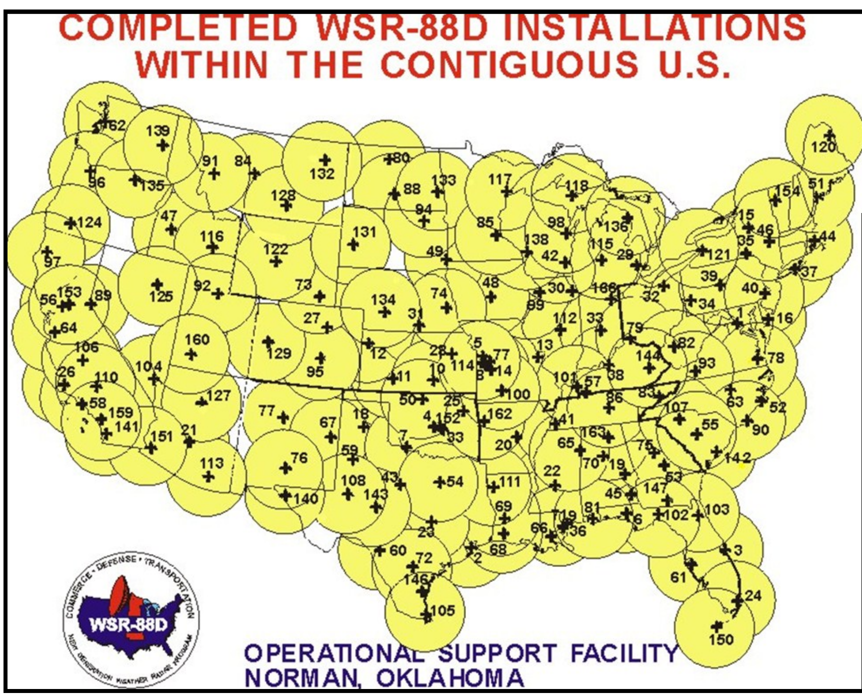
Cooperative observers across the country are provided equipment by their local NWS office for providing accurate observations on a daily basis. Each coop observing station is equipped with a digital thermometer that keeps track of current temperature as well as the minimum and maximum temperature. These stations also have a rain gauge. Several types of gauges are used: 8 inch gauges, 4 inch gauges, tipping bucket rain gauges and weighing gauges.

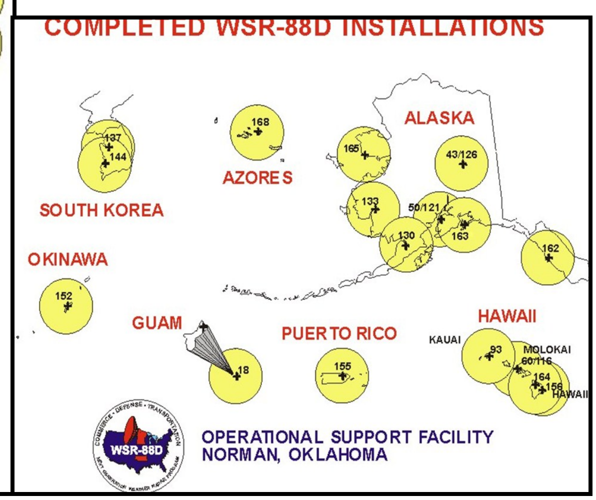
Doppler Weather Radar

The NEXRAD, also known as the Weather Surveillance Radar, 1988 Doppler (WSR-88D) is the most advanced operational weather radar network in the world; it gives meteorologists the ability to see "inside" a storm. Using the NEXRAD, forecasters can predict the weather with the aid of data such as reflectivity, velocity and spectrum width of an atmospheric disturbance. There are 159 operational NEXRAD radar systems deployed throughout the United States and at selected overseas locations. The maximum range of the NEXRAD radar is 250 nautical miles.

The WSR-88D system is comprised of Doppler radars, telecommunications, computer data communications, data processing hardware and software, display and data entry equipment, documentation and certain facilities and support capabilities required to detect, process, distribute, and display weather information in a manner which allows the DOC, the DOD and the DOT to fulfill their mission needs.

http://www.roc.noaa.gov/WSR88D/Default.aspx





Radar (cont.)

In addition to the WSR-88D radars that the NWS has in place across the country, a number of airports are also installing their own radar units. Terminal Doppler Weather Radars (TDWR) provide weather data in and around airports for FAA Air Traffic Controllers. The NWS developed the Supplemental Products Generator (SPG) to provide weather data from the FAA's TDWRs to NWS forecasters. The data can then be used to complement the data from WSR-88D systems to provide a backup during outages, fill in coverage gaps and provide a second data set to confirm the data from nearby WSR-88D radars.

Stream Gauges

Numerous observation sites are set up along rivers across the country to record water levels. Stream flow reading are also taken at these points at times to develop a stream flow curve for each location. These observations are used in issuing flood warnings, statements and forecasts. Several different types of river gauges are utilized: stilling well, bubbler, radar, acoustic and staff gauges. Most of these gauges record water levels multiple times an hour. Staff gauges are read as little as once per day. Frequently, river gauges are accompanied by rain gauges and temperature sensors. The NWS does not maintain all river gauges. Some are owned by cities or counties. Many are owned and maintained by the United States Geological Survey (USGS).

Marine and Tsunami Buoys

Marine buoys are utilized in oceans surrounding the United States as well as in the Great Lakes. These buoys provide observations of wind speed and direction as well as wave height that are essential in producing forecasts for offshore regions. Many of the buoys are also equipped with sensors to measure atmospheric pressure, temperature and dewpoint. The NWS and National Data Buoy Center own and operate many of the buoys and other offshore sensors, however some are owned by universities or other entities.

Tsunamis are detected by NOAA's DART® (Deep-ocean Assessment and Reporting of Tsunamis) buoy network. When a tsunami event occurs, the first information available about the source of the tsunami is based only on the available seismic information for the earthquake event. As the tsunami wave propagates across the ocean and successively reaches the DART systems, these systems report sea level information measurements back to the Tsunami Warning Centers, where the information is processed to produce a new and more refined estimate of the tsunami source. The result is an increasingly accurate forecast of the tsunami that can be used to issue watches, warnings or evacuations.

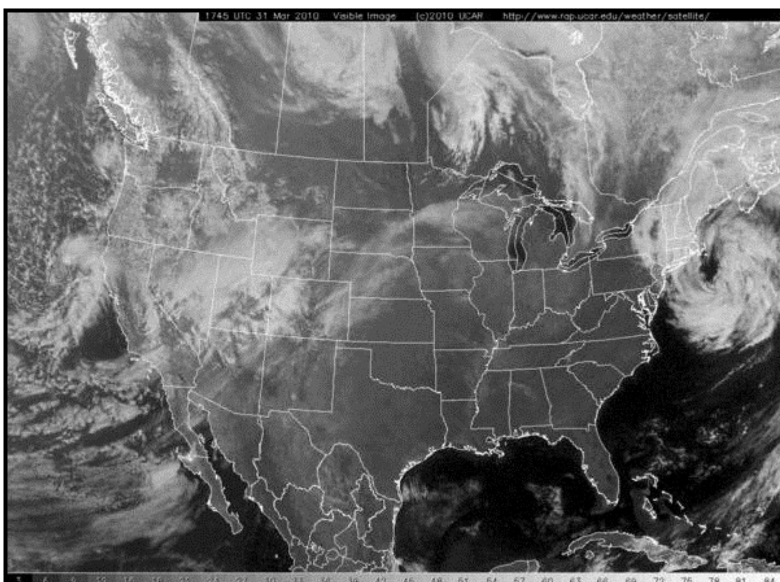
NOAA Weather Radio All Hazards

NOAA Weather Radio is a means of broadcasting weather information to homes across each office's county warning area. The system used within the NWS office is called Console Replacement System. CRS is used in the NWS office to maintain and organize products transmitted to the radio. Every state has numerous NWR transmitters outside of the NWS office to feed the signal to weather radios. For more information, see the Communication section.

Satellites

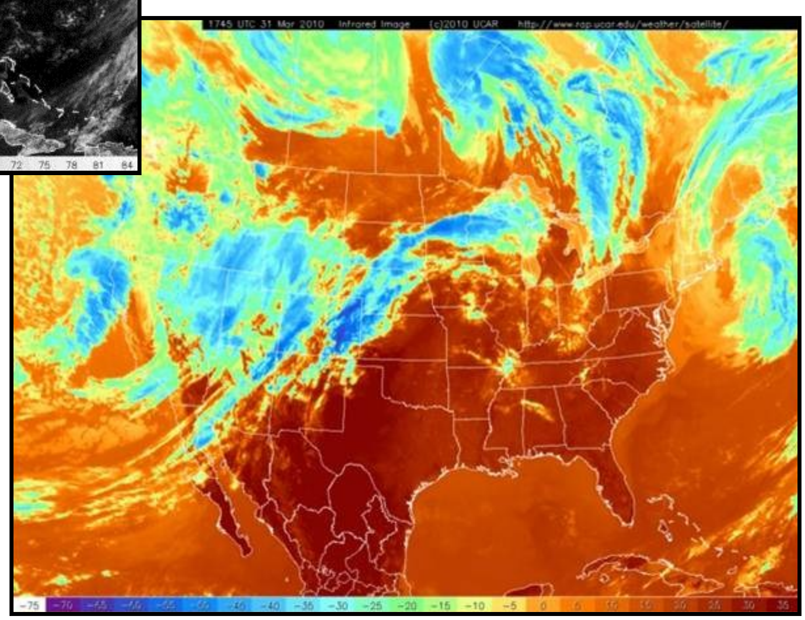
Satellite imagery is essential in accurately forecasting and nowcasting weather conditions. NOAA owns and operates a series of geostationary satellites known as GOES. These satellites maintain a stationary position above the earth. GOES-11 is currently operational over the western United States, and GOES-13 operates over the eastern U.S. Backup satellites are also in place in the event the current satellites fail. Satellite technology is continuously improving, and future satellites are expected to provide more frequent and higher resolution data.

Satellites provide multiple imaging products by reading several different wavelengths of electromagnetic energy. The two most commonly viewed products are the visible and infrared channel (shown below). Water vapor is also a commonly used product. Several others are also available.



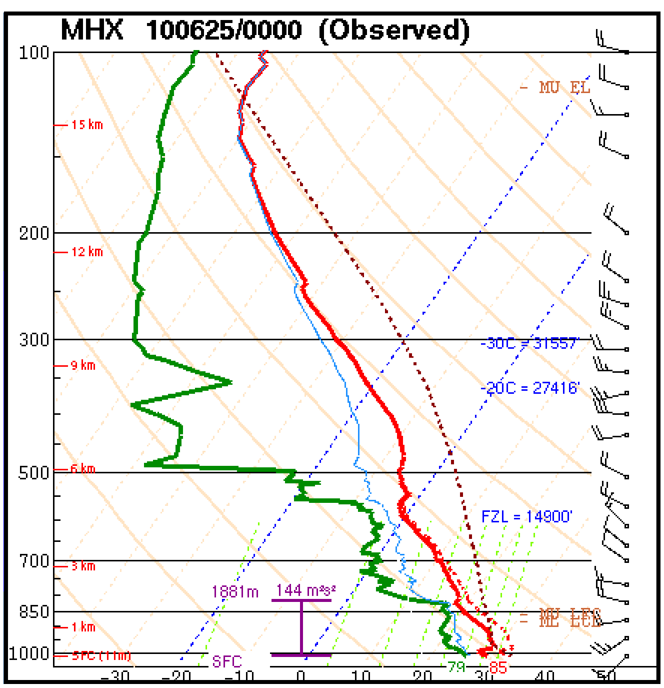
Visible Satellite Image

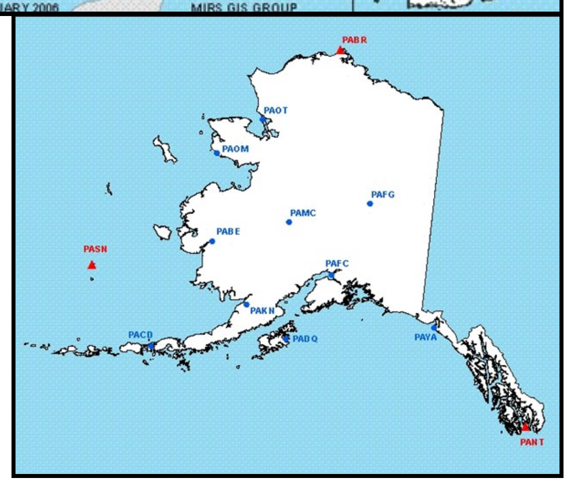
Infrared Satellite Image



Radiosondes and Upper Air Soundings

Conditions throughout the atmosphere are vital in the forecast process. In order to sample this data, the NWS uses radiosondes attached to weather balloons. At least twice a day, weather balloons are launched from 92 stations in North America and 10 locations in the Caribbean to gather important weather information vertically through the atmosphere. The weather balloon has a radiosonde package attached to it with instruments to measure temperature, pressure, winds and other atmospheric information.





Radiosonde output

Wind Profilers

The NWS also operates a network of 35 wind profilers throughout the central part of the U.S. and in Alaska. These units transmit waves into the air that work similarly to a Doppler radar. The radars detect fluctuations in the atmospheric density caused by turbulent mixing of volumes of air with slightly different temperature and moisture content. The resulting fluctuations of the index of refraction are used as a tracer of the mean wind in the clear air. The result is a measurement of the vertical wind at numerous levels above the ground.